

AORA

ATLANTIC OCEAN RESEARCH ALLIANCE

Atlantic Seabed Mapping Roadmap



This Vision Statement arises from the activities of the Atlantic Seabed Mapping International Work Group (hereafter referred to as Seabed Mapping Group), and is conducted through the Atlantic Ocean Research Alliance (AORA) between Canada, the European Union and the United States of America.

The progress and vision towards achieving a baseline seabed and habitat map of the Atlantic Ocean, was presented at the All Atlantic Ocean Research Forum, 6-7 February, 2020, in Brussels, Belgium. A diverse group of stakeholders participated in this work and the outcome summarised here is a result of extensive consultation with workshop and meeting participants, as well as others that were invited to comment on the work as it progressed. The editorial team would like to thank all those who contributed with comments and input.

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VERSION 1



EXECUTIVE SUMMARY

The Seabed Mapping Group has, in the last five years, defined and tested all the necessary steps to map the previously uncharted seafloor of the Atlantic Ocean. With the onset of the UN Decade of Ocean Science for Sustainable Development, the Seabed Mapping Group calls on the international leaders to provide the resources and framework necessary to achieve this ambitious goal, in order to deliver on their commitment to the Galway and Belém Statements. Creating an accurate fact based map of the Atlantic seafloor is essential for the sustainable use of our ocean, and will greatly help us to achieve the UN Sustainable Development Goal, **SDG 14 – Life Below Water**.

WHO ARE WE?

The Seabed Mapping Group is a team of experts from Canada, USA and Europe with representation from government, academia and industry, who are dedicated to furthering our knowledge and understanding of the Atlantic Ocean through comprehensive seabed and habitat mapping.

WHAT HAVE WE DONE?

In support of the Atlantic Ocean Research Alliance, between 2015 and 2020 we have surveyed over 1 million km² of Atlantic seabed, which although significant, is less than 8% of the northern Atlantic region. We have developed priority actions and next steps, identified through a series of collaborative seabed mapping initiatives, including joint research, transects of opportunity, industry engagement & partnership and dedicated mapping surveys. Conferences and workshops have been used to reach out and promote the need for and benefits of seabed mapping, and numerous media pieces and a number of articles and white papers have been published (www.atlanticresource.org).

* The priority is to map the Atlantic and generate a foundation data set to further our knowledge.

THE ATLANTIC SEABED ROADMAP

Mapping the depth, composition and habitat of the Atlantic Ocean seabed will fill a critical gap in our knowledge. These foundation data will allow us to better model the movement and behaviour of the ocean and the life within it. We will better understand the extreme changes we are witnessing in our weather and climate, better manage our responses to risks of coastal flooding and erosion, and more effectively deliver sustainable food production, energy and medicines.

ACHIEVING THIS WILL REQUIRE;

- Political will, support and financial resourcing
- Directing survey infrastructure to contribute systematic mapping
- Aligning survey effort and activity with the evolving Atlantic Mapping Plan
- A multi-dimensional approach including dedicated mapping, research cruises, industry mapping contracts, charitable foundation surveys and opportunistic data gathering
- Capacity build and training to coordinate and support acquisition and processing
- Data availability, harmonisation and standards
- Developing a survey operations structured framework to include;
 - Steering & oversight
 - Regional data acquisition coordination
 - Administration, procurement, reporting and progress tracking
 - Communications & PR
 - Industry, research & innovation coordination

The Atlantic Ocean is, through the preparatory activities of Seabed Mapping Group, in the best state of readiness for coast to coast and pole to pole seabed mapping. This provides an important opportunity for the partners of Canada, USA, the EU and other nations to **lead the world in exploring the entire seafloor**.

The Seabed Mapping Group have proven that **collaboration, technical innovation, and the sharing of data and information** acts as a crucial catalyst in exploring our oceans and giving us a better understanding of the **Last Great Frontier on Earth!**



INTRODUCTION

Maps and charts of the seas and oceans are often made for a specific use, or simply provide a very limited areal extent. Therefore a systematic approach is required. The Seabed Mapping Group has reviewed the local, regional and potential international benefits of mapping oceans.

REASONS TO MAP THE ATLANTIC

There are numerous reasons to Map the Atlantic, many of which are inter-related and connected in some manner.

The compelling reasons to map the Atlantic are relevant to Government, Industry, Society and the Scientific & Research community. Irrespective of community or sector, these reasons represent four main themes:

- 1 EXPLORATION** *Discovery/Knowledge/Understanding*
- 2 PROTECTION** *Preservation/Conservation/Monitoring*
- 3 RESOURCES** *Harvesting/Sustainable Exploitation*
- 4 GOVERNANCE** *Legislation/Rights/Management*

WHAT IS THE BACKGROUND TO THIS?

The Oceans have been neglected in terms of their mapping and we have a very limited understanding of their ecosystems and habitats. With less than 16% systematically surveyed*, the Seabed Mapping Group set out to identify priority areas, and assess appropriate methods and platforms to acquire and share the data needed to improve our knowledge and understanding.

The Seabed Mapping Group identified and defined suitable survey areas that are outside of national jurisdiction and not subject to international sovereignty claims.

* The figure of 16% is the official GEBCO 2019 grid value.

AORA

ATLANTIC OCEAN RESEARCH ALLIANCE

Underpinning the AORA are priorities set out in the Galway Statement on Atlantic Ocean Cooperation signed in May 2013. Four Working Groups were setup (Seabed Mapping, Ecosystem Approach to Ocean Health & Stressors, Aquaculture and Ocean Literacy), to trilaterally address the key challenges identified and propose recommendations, solutions, research priorities and actions for cooperation on and in the Atlantic.

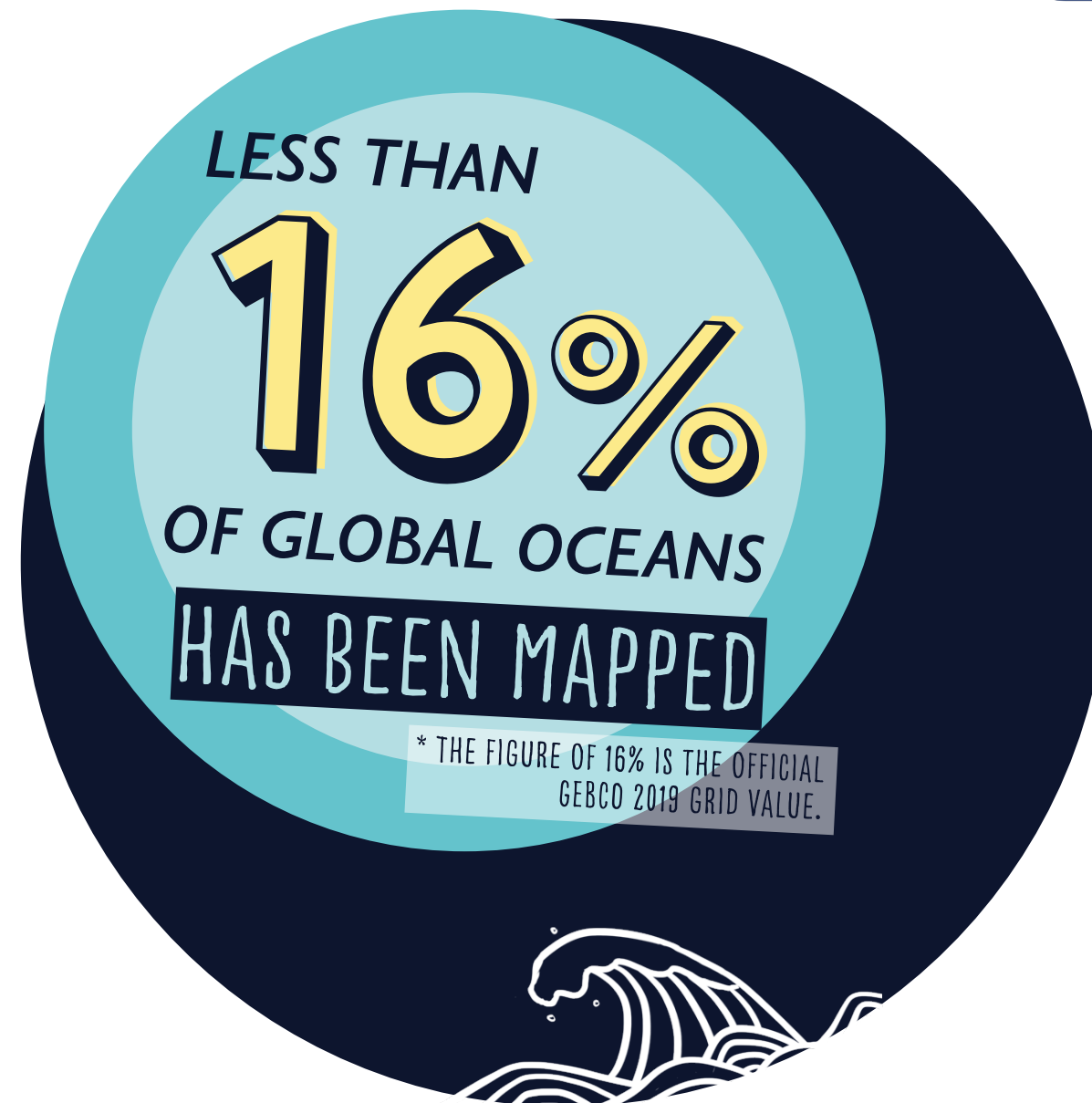
THE GALWAY STATEMENT ON ATLANTIC OCEAN COOPERATION

The Galway Statement on Atlantic Ocean Cooperation establishes a formal Atlantic Ocean Research Cooperation between Canada, Europe and the United States, to improve ecosystem knowledge, forecasting ability and achieve a deeper understanding of vulnerabilities and risks, including climate change.

ATLANTIC SEABED MAPPING INTERNATIONAL WORK GROUP

The Seabed Mapping Group aims to develop and implement a systematic seabed mapping strategy to deliver a unified seabed map of the Atlantic. It will reflect issues and priorities identified by hydrographers and ocean mapping experts, adhere to AORA objectives, and contribute to addressing the Galway & Belém Statements & UN Ocean Decade ambitions. Data availability, harmonisation and standards, as well as innovation, communication and the sharing of best practices, are central to this aim and essential to support the security of Atlantic Ocean resources.

The Seabed Mapping Group comprises science and policy representatives of government, academia, and industry from the United States of America, Canada, Europe, as well as invited expert contributors and observers. The inaugural meeting of the group took place in Brussels in February 2015 under AORA, and agreed to focus on **four main themes**.



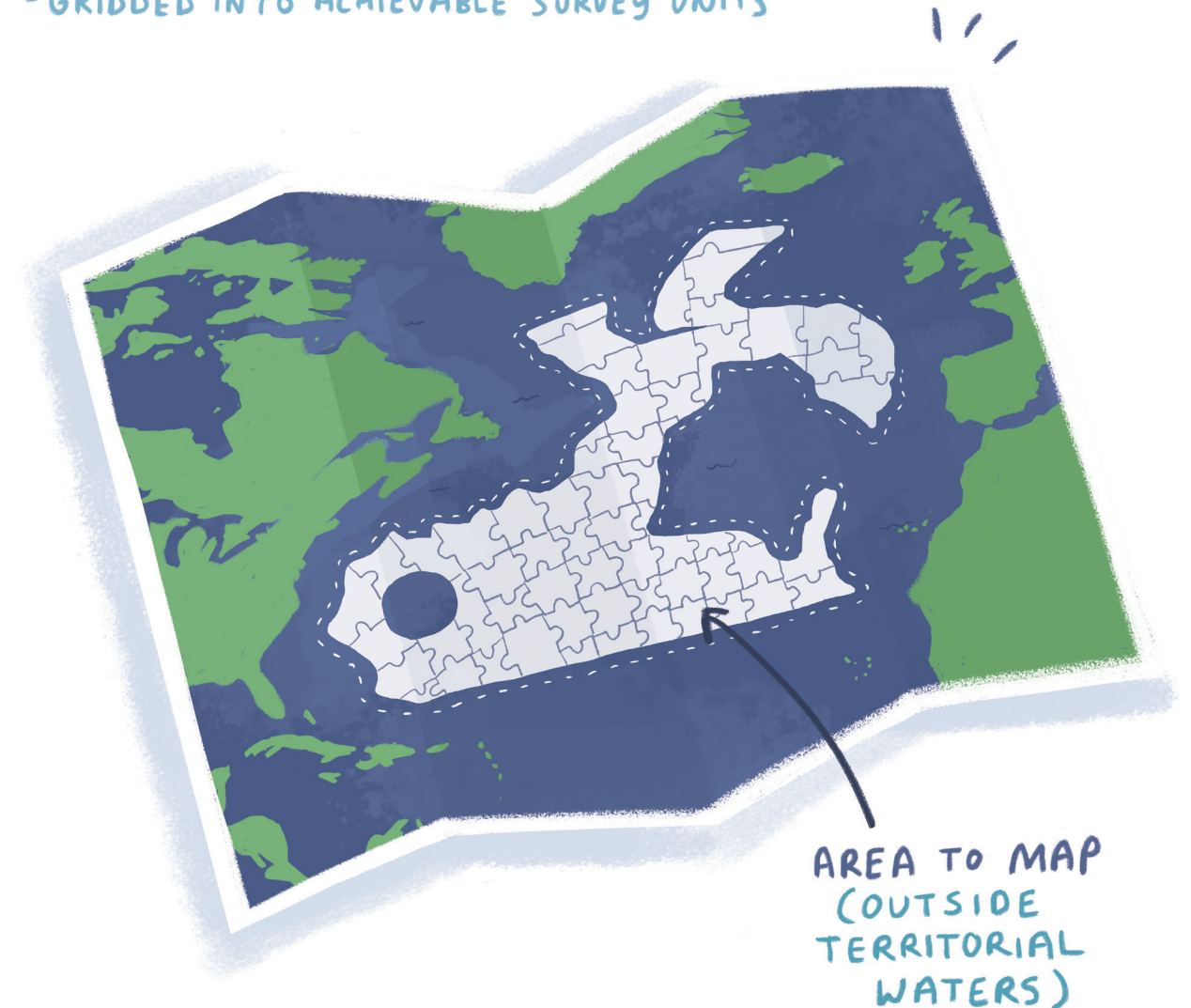
SEABED MAPPING GROUP FOCUS AREAS:

- **Leveraging** existing ocean exploration knowledge, infrastructure, technology and programmes;
- **Mapping** the seabed of the North Atlantic, identifying pilot areas and minimum data requirements;
- **Promoting** multidisciplinary survey, sharing best practice on survey planning & data management;
- **Communicating** the need for mapping the Atlantic Ocean seafloor, and the value of cooperation.

OBJECTIVES

- A** Establish the actions, priorities and mechanisms that will;
- (i) contribute to and catalyse increased Atlantic seabed mapping activity
 - (ii) ensure mapping outputs better enable ocean observation, modelling and forecasting
 - (iii) facilitate improved resource and risk management in the shared Atlantic area
- B** Identify the key issues & priorities that need to be addressed in order to prepare a unified seabed map of the shared Atlantic, including;
- (i) cost effective full coverage bathymetry data acquisition (i.e. seabed depth mapping)
 - (ii) determining follow-up benthic habitat mapping and ground truth requirements
 - (iii) application of standard methodologies and classification approaches
 - (iv) survey planning, progress and coverage information sharing
 - (v) data processing, interpretation, management, and dissemination
- C** Acknowledge and focus on the three identified priority issues;
- (i) Need for an Atlantic seabed map
 - (ii) Need to progress data availability, harmonization and standards
 - (iii) Need for improved communication and sharing of best practice

AREA OF THE NORTH ATLANTIC IN INTERNATIONAL WATERS - GRIDDED INTO ACHIEVABLE SURVEY UNITS



OUTCOMES

To date, the *Seabed Mapping Group* have estimated the survey effort and cost to map the North Atlantic seabed beyond territorial waters. Between 2015 and 2020 we have collectively surveyed over **1 Million Km² of Unmapped Atlantic Seabed** through a combination of opportunistic Atlantic transects, research cruises, and dedicated mapping surveys.

A North Atlantic Data Portal and prototype Data Viewer were developed, and data have been provided to the International Hydrographic Organization Data Centre for Digital Bathymetric and global Seabed2030 initiative. Significant capacity build and seagoing survey training opportunities have been provided, publications and white papers have been issued, and public awareness of the Atlantic seabed mapping initiative has greatly improved through the activities and efforts of the *Seabed Mapping Group*.

AORA MAPPING ACHIEVEMENT 2015-2020:

Significant bathymetry (depth) mapping contributions under AORA include four Irish *R.V. Celtic Explorer* Atlantic Transects, two Canadian Coast Guard transects by the *Louis St. Laurent*, and surveys by the French Ifremer *R.V. L'Atalante*, and the Spanish *R.V. Sarmiento*. The latter ExploreSea2 project also undertook a comprehensive habitat mapping assessment in collaboration with Portugal at the Mid-Atlantic Ridge, capturing spectacular images of newly discovered deep water sponges, and soft & hard coral habitats. The NOAA Ship *Okeanos Explorer* undertook a dedicated mapping survey south of Bermuda. Most significantly however, the recent combined efforts of the GEOMAR coordinated German research vessels and contributions from the Fugro fleet have more than doubled the overall mapping achieved under AORA to more than 1 million km² of previously un-surveyed Atlantic Ocean seafloor.



MAPPING TOGETHER

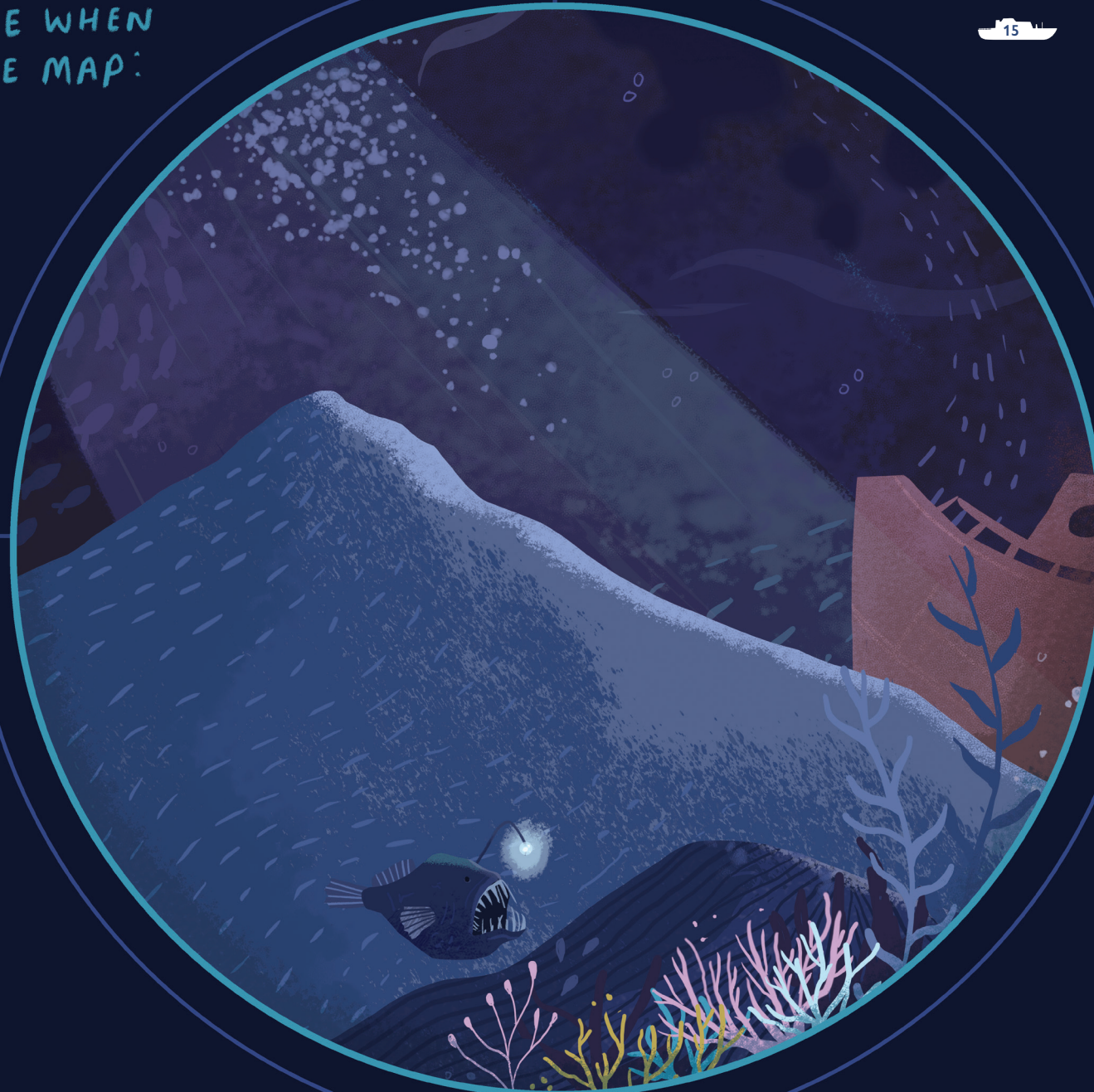
SHIPS AND RESEARCH CRUISES OF OPPORTUNITY

TRANSECT MAPPING – A PATHWAY TO RESEARCH:

In developing the approach to full coverage or systematic bathymetry (depth) mapping of the Atlantic, the Seabed Mapping Group has participated in eight joint ocean mapping transits, the most recent of which revisited a Mid-Atlantic seamount mapped during the first collaborative transatlantic crossing in 2015 onboard the R.V Celtic Explorer. The feature mapping raised scientific questions on the formation of this new oceanic crust, warranting a comprehensive geoscience & benthic habitat research investigation (TOSCA). This is one of the Seabed Mapping Group's demonstrators, validating the proposed approach for initial baseline bathymetry (depth) mapping, followed by targeted scientific and benthic habitat mapping studies.



WHAT WE CAN
SEE WHEN
WE MAP:



PILOT SURVEY

The Atlantic mapping roadmap developed by the **Seabed Mapping Group** incorporated design of a **400km x 400km grid configuration** of the North Atlantic. It focussed outside of areas of national territorial waters, and it incorporated pressure maps including human activities and sensitive habitats, to investigate a mapping prioritisation approach. The US **Okeanos Explorer** subsequently embarked upon the first AORA dedicated pilot mapping survey, targeting one of the prioritised Atlantic Survey Units south of Bermuda, achieving **mapping coverage of 52,812km²** and discovering exciting complex seabed features in what was previously assumed to be a characterless deep water abyssal plain.

MAPPING INNOVATION & TECHNOLOGY

Innovative approaches to improving survey efficiency have been trialled, including a successful remotely acquired **Atlantic multibeam transect** in 2017 onboard the R.V. Celtic Explorer. **Predictive sound velocity profiling** was applied to multibeam data, acquired by shore-based operators, **using satellite access** to the onboard mapping systems. **Remote mapping** is now routinely undertaken by **Fugro** during vessel transits, with efforts being expanded to contribute data to AORA and the global **Seabed2030** project. The challenge and need to evolve more cost effective mapping solutions is incentivising industry collaboration with groups, including **University of New Hampshire**, **NOAA** and **Marine Institute**, to develop and deploy innovative autonomous technologies for mapping the seas and oceans.

COMMUNICATING WHY MAPPING MATTERS

PROMOTION: Participants of the Seabed Mapping Group and related offshore survey activities have strongly endorsed and communicated the value and impact of seabed & habitat mapping, as well as contributing to significant related outreach and media engagement. Video production of the first AORA Atlantic Transect, national television and newspaper broadcasting of the initiative and survey findings, along with widely cast social media outputs including a National Geographic blog, capture some of the highlights.

* View the AORA One Frontier Left video [here](#)

EVENTS: The key Ocean Science & Hydrographic conferences in the North Atlantic region since 2015 have had Seabed Mapping Group representation, presentations, and focussed workshops. This includes contributions at Ocean Literacy specific conferences and events, including Ireland's SeaFest event with annual public attendance in excess of 100,000.

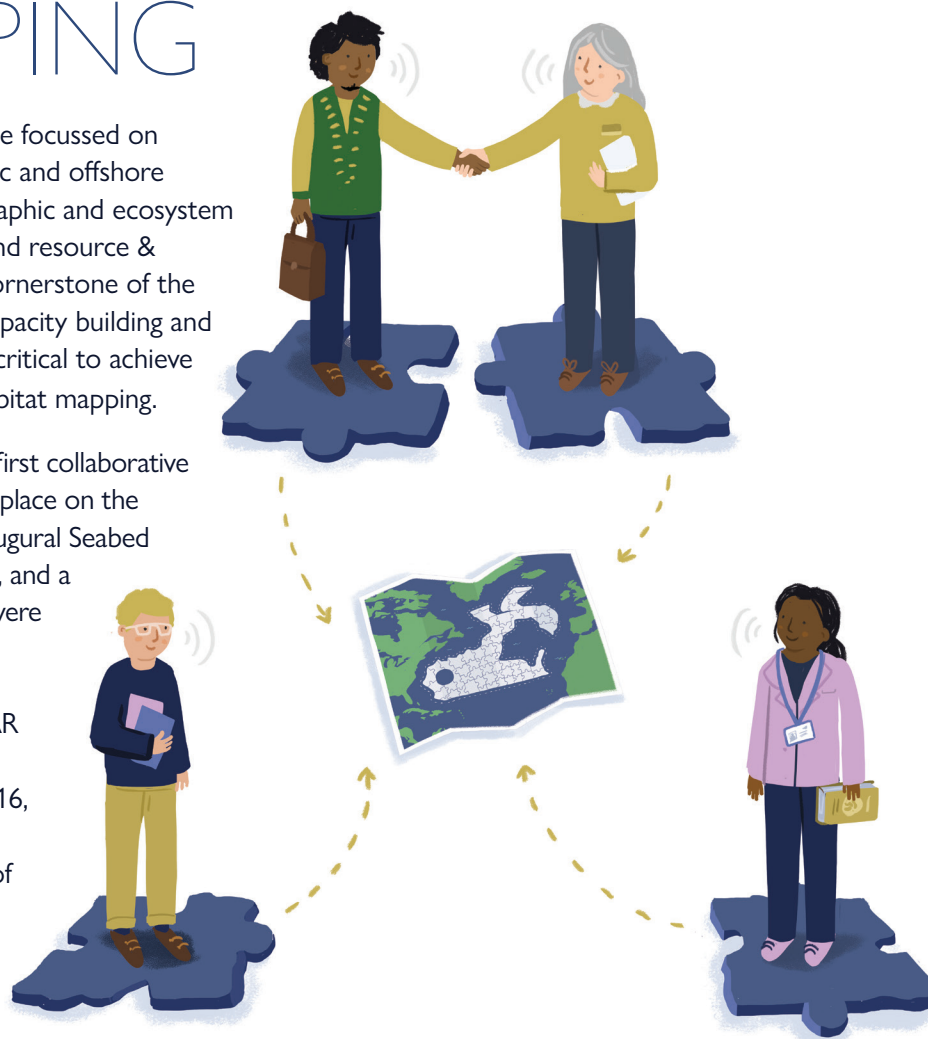
PARTNERSHIP: Recent international event representation has frequently been in partnership with the global Nippon Foundation-GEBCO Seabed 2030 initiative, leading to an increased recognition of the need for seabed mapping. This is evident from its inclusion as a cross cutting theme to be considered in key events for the EC Mission on healthy oceans, seas, coastal and inland waters, and the UN Decade of Ocean Science for Sustainable Development.



CAPACITY DEVELOPMENT IN MAPPING

The Seabed Mapping Group have focussed on technical aspects of hydrographic and offshore surveying to underpin oceanographic and ecosystem modelling, climate predictions and resource & risk management. However, a cornerstone of the conversation has focussed on capacity building and capacity development, which is critical to achieve Atlantic basin scale seabed & habitat mapping.

OFFSHORE TRAINING: The first collaborative AORA transatlantic survey took place on the R.V. Celtic Explorer after the inaugural Seabed Mapping Group meeting in 2015, and a multidisciplinary scientific team were mobilised to join the vessel from Europe, Canada and the USA. A Government of Ireland INFOMAR sponsored scholarship scheme was developed and piloted in 2016, funding trilateral participation of students in a Geological Survey of Ireland led transatlantic mapping and on-board training initiative (TRASNA). International student participation in survey activities have since been supported where feasible. This has increased researcher awareness of the Atlantic mapping challenge and interest in analysis and reporting of the associated discoveries and data.



PUBLICATIONS & OUTREACH

A number of articles, white papers and videos have been published:

OCEAN RESEARCH PAPERS

Wolfl, A-C; Jencks, J; Johnston, G; Varner, J; Devey, C; **Identifying Target Pilot Areas in the Deep Sea for an Atlantic Seabed Mapping Pilot Project using GIS Methods**, Journal of Ocean Technology Vol 12, no. 4 2017, Mapping the Deep

Wolfl, A-C; Snaith, H; Amirebrahimi, S; Devey, C; Dorschel, B; et al. **Seafloor Mapping – the Challenge of a truly global ocean bathymetry**, Frontiers in Marine Science, June 2019

ARTICLES & WHITE PAPERS

Wolfl, A-C; Jencks, J; Johnston, G; Varner, J; Devey, C; **Where Do We Map Next? A GIS Case Study From the Atlantic**, Hydro International, Oct 2018

Jencks, J; **Improving Sharing, Discovery and Access of Seafloor Data in the North Atlantic**, Atlantic Seabed Mapping International Working Group White Paper, 2016.

Gillespie, R., **“Understanding the characteristics of the seafloor and sub-surface of the North Atlantic–Technology Considerations”**, Atlantic Seabed Mapping International Working Group White Paper, October 29, 2015

Mortensen, P.B.; **BIBLIOGRAPHY OF SEABED AND HABITAT MAPPING Relevant for mapping in the offshore North Atlantic**, AORA Deliverable 9.2 Work Package 9 Seabed & Benthic Habitat Mapping (Bibliography to 2015)

AORA YOUTUBE PLAYLIST

AORA Seabed Mapping, <https://www.youtube.com/playlist?list=PLc59HdR7bhcSkJnUurqZvOu1UXE3tImjE>

MAPPING MISSING SEA MOUNTS

MOVING FROM A MODEL TO A MAPPED ATLANTIC OCEAN SEABED;

Recent seabed mapping has increased our understanding of the Atlantic and often reminded us of just how little we really know. What people often fail to realise, is that pictures of our Atlantic seabed are estimated from satellite measurements of sea surface height, not from direct scientific measurement of ocean depth. These models simply do not reflect the shape, depth, or complexity of the Atlantic seabed.

Underwater mountains previously uncharted were mapped during a transatlantic survey from Newfoundland, Canada to Galway, Ireland, and found to be larger than Ireland's highest mountain, Carrauntoohil. Putting real features of this scale on our ocean maps is essential to understand local upwelling and biodiversity conditions.

A region anticipated to be equivalent to deep sea desert on the Abyssal plain proved to have complex features which may indicate new and rich biodiversity and thus warranting further detailed investigation. The oceans clearly contain a wide variety of habitats many of which have yet to be discovered and fully investigated.

So while on one hand there is pressure to devise prioritisation criteria to determine where to map first, our discoveries and achievements to date clearly demonstrate that an area deemed less important by assessing our existing inaccurate modelled seafloor, could in fact prove to be the most bio-diverse, exciting and valuable.

It is the view of the **Seabed Mapping Group** therefore that future research and dedicated mapping effort should be resourced and targeted to;

- Fully map the seabed, so that new discoveries can be made & further investigated
- Contribute mapping to Atlantic Survey Units and existing coverage
- Deliver systematic mapping (cohesive full coverage multibeam data)
- Merge with and extend transit coverage, where systematic mapping isn't feasible



"ANYTHING BUT PLAIN,"
- MOST LIFE ON EARTH
IS IN THE OCEAN.



SEABED MAPPING CALL TO ACTION

The future evolution of the Atlantic is critical for many communities, regions, countries and society. This is recognised in the UN Sustainable Development Goals (SDG'S), many of which relate to the oceans, with SDG14 explicitly focussing on it, namely; **Life Below Water**. In this regard, having an accurate factual map of the Atlantic and global seafloor is essential for the sustainable use of our oceans.

The *Seabed Mapping Group* raise a **Call to Action** asking you to:

- **Resource & deploy** existing and new innovative **mapping infrastructure**
- **Align** survey priorities, planning, standards and effort to deliver **full coverage mapping**
- **Strengthen** capacity build through training, partnerships and Ambassador schemes
- **Collaborate** in research & dedicated mapping surveys, and **share** data & knowledge
- **Support** technologies & instrumentation development, or personnel **and funding commitment**

The *Seabed Mapping Group* estimate that it is a **5-year full time one vessel survey effort to map the North Atlantic**. With the UN Decade of Ocean Science for Sustainable Development (2021-2030) on the horizon, **WE CAN ACHIEVE THIS** ambitious but essential goal, and probably well beyond it considering the more cost effective autonomous mapping vehicles currently in development.

The *Seabed Mapping Group* is ready and available to **support, guide, advise and facilitate surveys and mapping efforts to realise a systematically mapped Atlantic**. New and exciting knowledge will drive better modelling, ocean management, food security and societal benefits.

The *Seabed Mapping Group* have demonstrated that the Atlantic is ready to be mapped. The opportunity and the time is **NOW** for international leaders to **resource, direct, and deliver a fully mapped Atlantic**, and to lead the exploration of the **last frontier** on Earth, the ocean seafloor.

In supporting the Atlantic Seabed Mapping, **YOU** will be some of the first explorers to discover the exciting, diverse and previously uncharted seabed environments and habitats that lie within our shared Atlantic Ocean.

WE CAN ACHIEVE THIS!



WE HAVE THE TOOLS, PEOPLE and TECHNOLOGY -
ALL WE NEED IS THE RESOURCING!



BYOM: (PLEASE) BRING YOUR OWN MULTIBEAM!

MAKING IT POSSIBLE

The Galway Statement on Atlantic Ocean Cooperation between the European Union, Canada and the United States of America



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